

Risk Factors for Postcesarean Wound Infection in a Tertiary Hospital in Lagos, Nigeria

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Abstract

Background: There has been a global increase in cesarean section rates. While this has improved perinatal outcome, it is associated with complications such as wound infection. We determined risk factors for cesarean section wound infection in a tertiary hospital in Lagos, Nigeria. **Materials and Methods:** We prospectively studied a cohort of 906 women who had cesarean section at the Obstetrics Unit of the Lagos State University Teaching Hospital between January 1, 2011, and December 31, 2011. A comparison was made between 176 women who had wound infection and 730 women who did not using logistic regression. **Results:** Of the 2134 deliveries during the study, 906 (42.5%) had cesarean section and of which 176 (19.4%) had wound infection. Independent risk factors for wound infection were: preoperative anemia (adjusted odds ratio [aOR] = 1.88; 95% confidence intervals [CI] = 1.03–3.41; $P = 0.0396$), presence of diabetes mellitus (aOR = 7.94; 95% CI = 1.60–39.27; $P = 0.0111$), HIV infection (aOR = 6.34; 95% CI = 1.74–23.06; $P = 0.0051$), prolonged operation time (aOR = 2.30; 95% CI = 1.19–4.42; $P = 0.0127$), excessive blood loss at surgery (aOR = 5.05; 95% CI = 2.18–11.66; $P = 0.0002$), and chorioamnionitis (aOR = 9.00; 95% CI = 1.37–59.32; $P = 0.0224$). **Conclusions:** Patients with HIV infection, diabetes mellitus, preoperative anemia and chorioamnionitis have an increased risk of postcesarean wound infection as is when surgical time exceeds 1 h or when associated with blood loss >1l.

Keywords: Cesarean section, Lagos, Nigeria, wound infection

INTRODUCTION

There has been a gradual increase in cesarean section rates and the increase has been a global phenomenon.¹⁻³ A high cesarean rate of 42.9% was recently reported from our institution.⁴ The World Health Organization however recommends a cesarean rate of 5%–15% in any facility.⁵

While it is generally agreed that this increasing trend toward cesarean deliveries have improved perinatal outcome, a number of observers have commented on a concomitant rise in the cost of hospitalization and the increased risk of operative complications of which wound infection is a major one.^{6,7} Wound infection is associated with higher maternal morbidity and costs associated with the management of patients with cesarean section compared to vaginal delivery as well as extended hospital stay.⁸ This puts more stress on the limited financial resources available to most hospitals in developing countries.^{8,9} The reported incidence of wound infection ranges from 3.0% to 16.2%.^{9,10}

Numerous studies have been published concerning the risk factors associated with cesarean section related morbidities and few have focused on cesarean section wound infection in Nigeria. Morhason-Bello *et al.*¹⁰ described the determinants of postcesarean section infection in 72 patients in Ibadan, western Nigeria, while Ojjiyi *et al.*¹¹ and Jido and Garba¹² carried out retrospective reviews of postcesarean wound infections in Awka, south eastern Nigeria and Kano in northern Nigeria, respectively.

Ezechi *et al.*¹³ studied postcesarean wound infection in four private hospitals in Lagos, Nigeria. This study however may not be a true representation of the situation in Lagos as it was

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conducted in highbrow private hospitals, mainly patronized by people of the high social class.

Our study took place in a tertiary hospital setting which receives referrals from lower cadre hospitals and is accessible to a wide range of the population in Lagos and its environs with a wide range of socioeconomic groups.

We therefore sought to determine the risk factors for early cesarean section wound infection (diagnosed prior to discharge from the hospital) at the Lagos State University Teaching Hospital. It is hoped that information obtained will be used to plan strategies to reduce postcesarean wound infection and add to the existing body of knowledge on the subject matter.

MATERIALS AND METHODS

We prospectively studied a cohort of 906 women who had cesarean section at the Obstetrics unit of the Lagos State University Teaching Hospital (LASUTH), Nigeria, between January 1, 2011, and December 31, 2011. The hospital is a referral center for private and public health institutions in Lagos and the neighboring states. Approximately 2000 deliveries take place per annum. Ethical approval for the study was obtained from the institution's ethics committee.

Data collection

All women who had either elective or emergency cesarean section during the study consented to participate and were enrolled. Information was obtained directly from patients, their clinical notes and referral letters using structured pro forma. Data were recorded daily by investigators and trained research assistants from admission through delivery till discharge. Women who had vaginal deliveries were excluded.

Data obtained include their sociodemographic characteristics, obstetrics characteristics, events in labor (for women who were in labor prior to cesarean section), surgical events and preoperative morbidities.

Blood loss was estimated by counting the number of soaked abdominal packs and gauzes, measurement of volume of blood expelled from the vagina after cesarean section and visual estimation of blood staining of the theater linen and drapes.

All the women received antibiotics prior to surgery as prophylactic antibiotics. Most regimens of antibiotics prior to surgery include ampicillins or a second-generation cephalosporin in addition to metronidazole. The antibiotics are usually continued for approximately 7 days, but the duration of use was variable.

The postoperative incision sites were examined every 48 h for any evidence of infection until patients were discharged. The diagnosis of early wound infection was made prior to discharge from the hospital. Swabs were obtained from infected wounds and cultured using standard microbiological methods.

Statistical analysis

Information obtained was entered into the computer and analyzed with the Epi-Info statistical software of the Center

for Disease Control and Prevention, Atlanta, Georgia, USA, version 3.5.3 (2011 edition). A comparison was made between women who had wound infection (cases) and those who did not (controls). Crude odds ratio (cOR) and 95% confidence intervals (CI) for possible risk factors for postcesarean wound infection were calculated using univariate analysis. Only risk factors with a $P < 0.05$ were fed into a multiple logistic regression model to obtain adjusted odds ratio (aOR) and determine independent risk factors for postcesarean wound infection.

Definition of terms

- Postcesarean wound infection: A wound was considered infected if there were indurations and swellings of the wound edges, discharge of pus or wound dehiscence
- Unbooked patient: Defined as a patient who was not registered for antenatal care in LASUTH
- Prolonged operation time: Defined as cesarean section lasting more than 1 h from skin incision to last skin stitch
- Prolonged hospital stay: Defined as hospital admission lasting more than 7 days
- Preoperative anemia: Defined as preoperative packed cell volume $< 30\%$
- Excessive blood loss: Defined as an estimated blood loss of 1000 ml or more at the conclusion of surgery
- Obesity: Defined as body mass index $\geq 30 \text{ kg/m}^2$
- The socioeconomic class was calculated using the formula: (education score $\times 0.5$) + (occupation score $\times 0.6$). Scores were classified as low = 30–55; medium = 56–65; high = 60–80.¹⁴

Wound infection:¹⁵

- a. Superficial wound infection
 - i. Where serous or turbid discharge was present (with or without positive wound culture)
 - ii. Where there was minor wound dehiscence ($< 2 \text{ cm}$)
- b. Deep wound infection
 - i. Where the wound drained purulent material
 - ii. Where wound dehiscence was $> 2 \text{ cm}$
 - iii. Where cellulitis and indurations exceeded 2 cm in diameter.

RESULTS

A total of 2134 deliveries occurred during the study of which 906 had cesarean section. The cesarean section rate was 42.5%. One hundred and seventy-six (19.4%) of 906 cases were complicated by wound infection. Of these 176 with wound infection, 139 (79%) had superficial wound infection, while 37 (21%) had deep wound infection.

Table 1 shows the comparison of cases and controls with regards to the socio-demographic characteristics. Being in the middle (cOR = 0.62; 95% CI = 0.44–0.88; $P = 0.0074$) and upper social class (cOR = 0.37; 95% CI = 0.20–0.68; $P = 0.0012$) reduced the risk of wound infection compared to being in the lower social class.

Table 2 shows the obstetrics characteristics of the cases and controls. The parity of the patient, number of fetuses and the gestational age at delivery were not significant determinants of postcesarean wound infection. Being unbooked (cOR = 1.80; 95% CI = 1.28–2.53; $P = 0.0007$) increased the risk of postcesarean wound infection while the presence of previous uterine scar (cOR = 0.56; 95% CI = 0.38–0.82; $P = 0.0028$) was associated with a reduced risk of postcesarean wound infection.

Table 3 shows the comparison of cases and controls with respect to labor events. The labor onset and the number of vaginal examinations were not significant determinants of postcesarean wound infection. Prolonged rupture of membranes (cOR = 16.51; 95% CI = 6.17–44.13; $P = 0.0000$), prelabor rupture of membranes (cOR = 3.39; 95% CI = 1.87–6.15;

$P = 0.0001$), prolonged labor (cOR = 5.42; 95% CI = 3.25–9.02; $P = 0.0000$), and cesarean section done in the second stage of labor as against that done in the first stage (cOR = 4.51; 95% CI = 2.36–9.65; $P = 0.0000$) significantly increased the risk of postcesarean wound infection.

Table 4 shows the comparison of cases and controls with respect to surgical events. The time of surgery and type of incisions were not significant determinants of wound infection. Prolonged operation time (cOR = 5.52; 95% CI = 3.86–9.89; $P = 0.0000$) and excessive blood loss at surgery (cOR = 9.84; 95% CI = 6.34–17.27; $P = 0.0000$) increased the risk of postcesarean wound infection. Elective compared to emergency surgery (cOR = 0.37; 95% CI = 0.25–0.56; $P = 0.0000$), surgery performed by registrars compared to consultants (cOR = 0.15;

Table 1: Demographic characteristics of women who had wound infection (cases) and those that did not have (controls)

Characteristics	Cases ($n=176$), n (%)	Controls ($n=730$), n (%)	cOR	95% CI	P
Age					
<20	3 (1.7)	5 (0.9)	1.00	Reference	Reference
20-34	141 (80.1)	586 (80.2)	0.40	0.09-1.70	0.0214
≥35	32 (18.2)	139 (19.0)	0.38	0.08-1.69	0.2052
Marital status					
Single	29 (16.5)	87 (11.9)	0.67	0.23-1.94	0.4561
Married	126 (71.6)	585 (80.1)	0.43	0.16-1.16	0.0984
Separated	10 (5.7)	27 (3.7)	0.74	0.21-2.50	0.6295
Widowed	5 (2.8)	19 (2.6)	0.53	0.13-2.11	0.3653
Divorced	6 (9.7)	12 (1.6)	1.00	Reference	Reference
Social class					
Upper	14 (8.0)	114 (15.6)	0.37	0.20-0.68	0.0012
Middle	71 (40.3)	343 (47.0)	0.62	0.44-0.88	0.0074
Lower	91 (51.7)	273 (37.4)	1.00	Reference	Reference
Religion					
Christianity	140 (79.5)	55 (7.5)	0.79	0.52-1.21	0.2980
Islam	36 (20.5)	179 (24.5)	1.00	Reference	Reference

COR: Crude odds ratio, CI: Confidence interval

Table 2: Obstetrics Characteristics of patients who had wound infection (cases) and those that did not have (controls)

Characteristics	Cases ($n=176$), n (%)	Controls ($n=730$), n (%)	cOR	95% CI	P
Parity					
0	41 (23.3)	134 (18.4)	1.00	Reference	Reference
1-4	117 (66.5)	541 (74.1)	0.71	0.47-1.06	0.0914
≥5	18 (10.2)	55 (7.5)	1.07	0.56-2.02	0.8359
Number of fetus					
Single	158 (89.8)	657 (90.0)	0.98	0.57-1.68	0.9283
Multiple	18 (10.2)	73 (80.2)	1.00	Reference	Reference
Gestational age					
Term	164 (93.2)	6671 (91.4)	1.76	0.85-3.60	0.1260
Preterm	12 (6.8)	63 (8.6)	1.00	Reference	Reference
Booking status					
Not booked	73 (41.5)	206 (28.2)	1.80	1.28-2.53	0.0007
Booked	103 (58.5)	524 (71.8)	1.00	Reference	Reference
Previous uterine scar					
Yes	41 (23.3)	257 (35.2)	0.56	0.38-0.82	0.0028
No	135 (76.7)	473 (64.8)	0.97	Reference	Reference

COR: Crude odds ratio, CI: Confidence interval

Table 3: Labor events of patients who had wound infection (cases) and those that did not (controls)

Characteristics	Cases (n=124),n (%)	Controls (n=316),n (%)	cOR	95% CI	P
Labour onset					
Spontaneous	122 (98.4)	303 (95.9)	2.62	0.58-11.77	0.2098
Induced	2 (1.6)	13 (4.1)	1.00	Reference	Reference
Duration of membrane rupture					
Prolonged	34 (27.4)	21 (6.6)	16.50	6.17-44.13	0.0000
Not prolonged	90 (72.6)	295 (93.4)	1.00	Reference	Reference
Prelabor rupture of membrane					
Yes	27 (21.8)	24 (7.6)	3.39	1.87-6.15	0.0001
No	97 (78.2)	292 (92.4)	1.00	Reference	Reference
Number of vaginal examinations					
Multiple	116 (93.5)	301 (95.3)	1.00	Reference	Reference
Not multiple	8 (6.5)	15 (4.7)	1.02	0.39-2.69	0.9676
Duration of labor					
Prolonged	48 (38.7)	33 (10.4)	5.42	3.25-9.02	0.0000
Not prolonged	76 (61.3)	283 (89.6)	1.00	Reference	Reference
Second stage cesarean section					
Yes	13 (10.5)	8 (2.5)	4.51	2.36-9.65	0.0000
No	111 (89.5)	308 (97.5)	1.00	Reference	Reference

COR: Crude odds ratio, CI: Confidence interval

Table 4: Surgical events of patients who had wound infection (cases) and those that did not (controls)

Characteristics	Cases (n=176),n (%)	Controls (n=730),n (%)	cOR	95% CI	P
Prolonged operation time					
Yes	88 (50.0)	112 (15.3)	5.52	3.86-7.89	0.0000
No	88 (50.0)	618 (84.7)	1.00	Reference	Reference
Excessive blood loss					
Yes	65 (30.9)	41 (5.6)	9.84	6.34-17.27	0.0000
No	111 (63.1)	689 (94.4)	1.00	Reference	Reference
Type of surgery					
Elective	33 (18.8)	279 (38.2)	0.37	0.25-0.56	0.0000
Emergency	143 (81.2)	451 (61.8)	1.00	Reference	Reference
Cadre of surgeons					
Registrars	68 (38.6)	358 (49.0)	0.15	0.07-0.29	0.0000
Senior registrar	87 (49.4)	356 (48.8)	0.19	0.09-0.37	0.0000
Consultant	21 (12.0)	16 (2.2)	1.00	Reference	Reference
Time of surgery					
Regular hours	83 (47.2)	397 (54.4)	0.75	0.54-1.04	0.0853
Call hours	93 (52.8)	333 (45.6)	1.00	Reference	Reference
Type of abdominal incision					
Transverse	172 (97.7)	715 (97.9)	0.90	0.30-2.75	0.8563
Midline	4 (2.3)	15 (2.1)	1.00	Reference	Reference

COR: Crude odds ratio, CI: Confidence interval

95% CI = 0.07–0.29; $P = 0.0000$) and surgery performed by senior registrars compared to consultants (cOR = 0.19; 95% CI = 0.09–0.37; $P = 0.0000$) decreased the risk of postcesarean wound infection.

Table 5 shows the comparison of cases and controls with respect to associated preoperative morbidities. The presence of chorioamnionitis (cOR = 20.50; 95% CI = 9.99–42.03; $P = 0.0000$), hypertension (cOR = 1.90; 95% CI = 1.33–2.72; $P = 0.004$), diabetes mellitus (cOR = 10.61; 95% CI = 3.68–30.5; $P = 0.0000$), preoperative anemia (cOR = 4.54;

95% CI = 3.19–6.45; $P = 0.00000$), presence of uterine fibroids (cOR = 4.87; 95% CI = 1.85–12.79 $P = 0.0013$), HIV infection (cOR = 2.71; 95% CI = 1.42–5.17; $P = 0.0025$), and preoperative fever (cOR = 17.13; 95% CI = 7.99–36.74; $P = 0.0000$) increased the risk of postcesarean wound infection.

After entering the significant factors in the univariate analysis into a multiple logistic regression model for multivariate analysis [Table 6], social class, booking status, previous uterine scar prolonged labor, prolonged rupture of membranes, prelabor rupture of membranes, second-stage cesarean section, type of

Table 5: Preoperative morbidities of patients who had wound infection (cases) and those that did not (controls)

Characteristics	Cases (n=176),n (%)	Controls (n=730),n (%)	cOR	95% CI	P
Clinical chorioamnionitis					
Yes	39 (22.2)	10 (1.4)	20.50	9.99-42.03	0.0000
No	137 (77.8)	720 (98.6)	1.00	Reference	Reference
Hypertension					
Yes	12 (6.3)	114 (15.7)	1.90	1.33-2.72	0.0004
No	164 (93.7)	610 (84.3)	1.00	Reference	Reference
Diabetes					
Yes	12 (6.3)	5 (0.7)	10.61	3.68-30.5	0.0000
No	164 (93.7)	725 (99.3)	1.00	Reference	Reference
Cardiac disease					
Yes	1 (0.6)	16 (2.2)	0.26	0.03-1.93	0.1858
No	175 (99.4)	714 (97.8)	1.00	Reference	Reference
Preoperative anaemia					
Yes	118 (67.0)	226 (31.0)	4.54	3.19-6.45	0.0000
No	58 (33.0)	504 (69.0)	1.00	Reference	Reference
Uterine fibroids					
Yes	9 (5.1)	8 (1.1)	4.86	1.85-12.79	0.0013
No	167 (94.9)	722 (98.9)	1.00	Reference	Reference
Obesity					
Yes	81 (46.0)	358 (49.0)	1.02	0.73-1.41	0.9049
No	95 (54.0)	372 (51.0)	1.00	Reference	Reference
HIV infection					
Yes	16 (9.1)	26 (3.6)	2.71	1.42-5.17	0.0025
No	160 (9.9)	703 (9.4)	1.00	Reference	Reference
Preoperative fever					
Yes	31 (17.6)	9 (1.2)	17.13	9.99-36.74	0.0000
No	145 (82.4)	721 (98.8)	1.00	Reference	Reference

COR: Crude odds ratio, CI: Confidence interval

Table 6: Multivariate logistic regression analysis of significant factors to predicting independent risk factors for cesarean section wound infection

Factors	aOR	95% CI	P
Preoperative anemia	1.88	1.03-3.41	0.0396
Social class (middle/lower)	0.71	0.39-1.28	0.2507
Social class (upper/lower)	0.41	0.15-1.08	0.0715
Not booked	0.94	0.51-1.74	0.8462
Previous uterine scar	1.32	0.52-3.37	0.5636
Prolonged labor	1.83	0.79-4.24	0.1588
Prolonged rupture of membrane	2.88	0.68-12.26	0.1514
Prelabor rupture of membrane	1.14	0.40-3.21	0.8109
Diabetes mellitus	7.94	1.60-39.27	0.0111
HIV infection	6.34	1.74-23.06	0.0051
Second stage cesarean section	1.20	1.00-13.60	0.9612
Elective cesarean section	0.41	0.02-7.23	0.5411
Cadre of surgeon (registrar/consultant)	0.89	0.03-5.54	0.9596
Cadre of surgeon (Snr Registrar/consultant)	0.94	0.11-5.92	0.9595
Hypertension	0.63	0.24-1.67	0.3519
Uterine fibroids	0.59	0.07-5.38	0.9397
Preoperative fever	0.54	0.08-3.73	0.5333
Prolonged operation time	2.30	1.19-4.42	0.0127
Excessive blood loss	5.05	2.18-11.66	0.0002
Chorioamnionitis	9.00	1.37-59.32	0.0224

aOR: Adjusted odds ratio, CI: Confidence interval

surgery (elective or emergency), cadre of surgeon, presence of hypertension, presence of uterine fibroids, and preoperative fever were no longer significant factors for postcesarean wound infection. The factors that remained significant were: preoperative anemia (aOR = 1.88; 95% CI = 1.03–3.41; $P = 0.0396$), presence of diabetes mellitus (aOR = 7.94; 95% CI = 1.60–39.27; $P = 0.0111$), HIV infection (aOR = 6.34; 95% CI = 1.74–23.06; $P = 0.0051$), prolonged operation time (aOR = 2.30; 95% CI = 1.19–4.42; $P = 0.0127$), excessive blood loss at surgery (aOR = 5.05; 95% CI = 2.18–11.66; $P = 0.0002$), and chorioamnionitis (aOR = 9.00; 95% CI = 1.37–59.32; $P = 0.0224$).

DISCUSSION

The incidence of postcesarean wound infection of 19.4% reported from this study is higher than 9.3% reported by Ezechi *et al.*,¹³ from four private hospitals in Lagos, Nigeria. The difference in infection rates may be explained by the fact that our hospital serves a population with a mixture of high and low risk patients and receive referrals from lower cadre hospitals and is accessible to a wide range of socioeconomic groups. This contrasts with the study by Ezechi *et al.* which took place in highbrow private hospitals patronized mainly by people of the middle and upper socioeconomic class. Our rate of wound infection is however also higher than 16.2% reported

from the University College Hospital, Ibadan, Nigeria, which also serves as a referral hospital for its environs.¹⁰ A rate of 11% was reported from the Hawassa University Teaching and Referral Hospital Ethiopia.¹⁶ Much lower rates are reported from developed countries. A rate of 5.5% was reported from a United States academic institution¹⁷ while a rate of 5.2% was reported from Wellington, New Zealand.¹⁸

From a theoretical point of view, comorbidities can decrease the body's ability to fight infections. Most of the previous studies evaluating risk factors for postcesarean wound infections however did not look at the effect of comorbid conditions. This study demonstrated an independent association between postcesarean wound infection and diabetes, HIV infection, and preoperative anemia.

The presence of diabetes mellitus increased the risk of postcesarean wound infection about eight-fold in this study. There is a consensus among clinicians that diabetic patients are at increased risk of developing infections. This special vulnerability has been attributed to impaired leucocyte function, associated vascular diseases, poor glucose control and altered host response and nutritional deficiency.^{19,20} It is pertinent to note that only few studies have previously studied the association between diabetes and postcesarean wound infection. A study from a tertiary hospital in Riyadh, Saudi Arabia, demonstrated an increased risk of postcesarean wound infection by 2.28-fold in diabetics compared to nondiabetics.⁸ Schneid-Kofman in Israel also demonstrated an increased risk of postcesarean wound infection in diabetics compared to nondiabetics.²¹ A study from New York USA however failed to demonstrate an association between diabetes mellitus and postcesarean wound infection.²² Maintaining normoglycemia is important in diabetics as hyperglycemia has been correlated with impaired wound healing.²³ To optimize wound healing potential, diabetic patients should be encouraged to achieve target levels for glycosylated hemoglobin before pregnancy.

This study also demonstrated an association of preoperative anemia with postcesarean wound infection increasing the risk almost two-fold. This is similar to findings from recent studies in Hungary²⁴ and China²⁵ respectively. Ezechi *et al.*¹³ in Lagos, Nigeria, and Jido and Garba¹² in Kano, Northern Nigeria however did not demonstrate an independent association between preoperative anemia and postcesarean wound infection.

Our study also demonstrated an increased risk of wound infection of at least six-fold in HIV-positive women compared to HIV negative women and this finding is similar to that reported from a study in a low resource African setting.²⁶ A study involving 156 HIV-positive women who had cesarean section in Italy also showed that they are at increased risk of wound infection especially in those who were severely immunocompromised with CD4 lymphocyte count $<200 \times 10^6/l$.²⁷ Most of the HIV-positive women in this study could not do the CD4 lymphocyte count before delivery to ascertain the severity of the disease and it is very likely

that a lot of them do not have the disease properly managed before delivery because many present for antenatal care late and many are diagnosed for the first time in pregnancy, often in advanced gestation and consequently commence anti-retroviral drugs late. It is also not uncommon for women who are not booked in our center but were referred from other centers to be diagnosed with HIV for the first time in labor and consequently not received the regular antiretroviral drugs before delivery. The end result is improper control of the disease before delivery. Urbani *et al.*²⁸ in South Africa and Sekirime and Lule²⁹ in Uganda however did not find any significant difference in cesarean section wound infection in HIV-infected women and controls.

Some previous studies demonstrated an association between prolonged operation time and wound infection.¹¹⁻¹³ It was therefore not surprising that our study demonstrated that prolonged operation time of more than 1 h increased the risk of wound infection more than 2-fold. It is possible that prolonged operation time is associated with significant tissue handling, resulting in decreased tissue perfusion, tissue devitalization, and increased blood loss. Morhason-Bello *et al.*¹⁰ however did not demonstrate any association between operation time and wound infection.

The risk of postcesarean wound infection has also been shown in some previous studies to be associated with excessive blood loss at surgery. This study demonstrated that excessive blood loss at surgery more than 1 l increased the risk of postcesarean wound infection 5-fold. A high volume of blood loss is usually associated with poor control of bleeding and increased tissue damage from prolonged retraction and manipulations. The finding from our study is similar to that reported by Jido and Garba¹² from the Aminu Kano Teaching Hospital, Kano, Nigeria and also the report by Tran *et al.*³⁰ from Hungvuong Hospital in Ho Chi Minh City, Vietnam. The hospital is a referral center for 18 district hospitals. Morhason-Bello *et al.*¹⁰ however did not demonstrate an association between blood loss and postcesarean wound infection in Ibadan, Nigeria.

Chorioamnionitis have been shown to be associated with postcesarean wound infection.^{22,30} Our study demonstrated a 9-fold risk of postcesarean wound infection when there is a diagnosis of chorioamnionitis. This may not only compromise the immune system but can also increase the potential of microorganisms contaminating the surgical site. Prompt and aggressive antibiotics therapy should be started as soon as suspected infection is confirmed to reduce subsequent postoperative infections.

It is instructive to note that obesity was not significantly associated with postcesarean wound infection in this study even though most previous studies have reported that obese women are at risk of poor wound healing with incision complications and infection.^{13,21,30-32} It is possible that because of anticipated complications, the surgeons were more meticulous with their surgeries.

It is also worthy of note that some of the previous studies were able to demonstrate an association between postcesarean section wound infection and prolonged rupture of membranes, preterm prelabor rupture of membranes and also prolonged labor.^{11,13,25} These factors are some of the major factors associated with chorioamnionitis which is a significant factor for wound infection in this study. These factors were significant on univariate analysis but failed to reach significant level after correcting for co-founding variables.

CONCLUSIONS

This study is limited by its restriction to a single institution, thus, the findings may not be generalizable and also by the fact that all patients did not take the same brand of antibiotics and the duration of antibiotics intake also varied. The study however demonstrates that postoperative wound infection commonly complicates cesarean section in our unit. Patients with HIV infection, diabetes mellitus, preoperative anemia, and chorioamnionitis have an increased risk of postcesarean wound infection as is when surgical time exceeds 1 h or when associated with blood loss greater than 1 liter. Information regarding the risk of postcesarean wound infection associated with these conditions should be provided to women undergoing cesarean section and these characteristics should be incorporated into approaches for the prevention of postcesarean wound infection, especially in our environment.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Ye J, Zhang J, Mikolajczyk R, Torloni MR, Gülmezoglu AM, Betran AP. Association between rates of caesarean section and maternal and neonatal mortality in the 21st century: A worldwide population-based ecological study with longitudinal data. *BJOG* 2016;123:745-53.
- Betrán AP, Ye J, Moller AB, Zhang J, Gülmezoglu AM, Torloni MR. The increasing trend in caesarean section rates: Global, regional and national estimates: 1990-2014. *PLoS One* 2016;11:e0148343.
- Rai SD, Regmi PR, Tejjlingen EV, Wood J, Dangal G, Dhakal KB. Rising rates of caesarean section in urban Nepal. *J Nepal Health Res Counc* 2019;16:479-80.
- Rabiu KA, Adewunmi AA, Akinola OI, Eti AE, Tayo AO. Comparison of maternal and neonatal outcomes following caesarean section in second versus first stage of labour in a tertiary hospital in Nigeria. *Niger Postgrad Med J* 2011;18:165-71.
- Chalmers B, Mangiaterra V, Porter R. WHO principles of perinatal care: The essential antenatal, perinatal, and postpartum care course. *Birth* 2001;28:202-7.
- Wloch C, Wilson J, Lamagni T, Harrington P, Charlett A, Sheridan E. Risk factors for surgical site infection following caesarean section in England: Results from a multicentre cohort study. *BJOG* 2012;119:1324-33.
- Blumenfeld YJ, El-Sayed YY, Lyell DJ, Nelson LM, Butwick AJ. Risk factors for prolonged postpartum length of stay following cesarean delivery. *Am J Perinatol* 2015;32:825-32.
- Habib FA. Incidence of post cesarean section wound infection in a tertiary hospital, Riyadh, Saudi Arabia. *Saudi Med J* 2002;23:1059-63.
- Zuarez-Easton S, Zafran N, Garmi G, Salim R. Postcesarean wound infection: Prevalence, impact, prevention, and management challenges. *Int J Womens Health* 2017;9:81-8.
- Morhason-Bello IO, Oladokun A, Adedokun BO, Obisesan KA, Ojengbode OA, Okuyemi OO. Determinants of post-caesarean wound infection at the University College Hospital Ibadan Nigeria. *Niger J Clin Pract* 2009;12:1-5.
- Ojiyi EC, Dike EI, Okeudo C, Ejikem EC, Nzewuihe AC. Wound infection following caesarean section in a university teaching hospital in South-East Nigeria. *Orient J Med* 2013;25:8-13.
- Jido T, Garba I. Surgical-site infection following cesarean section in Kano, Nigeria. *Ann Med Health Sci Res* 2012;2:33-6.
- Ezechi OC, Edet A, Akinlade H, Gab-Okafor CV, Herbertson E. Incidence and risk factors for caesarean wound infection in Lagos Nigeria. *BMC Res Notes* 2009;2:186.
- Green LW. Manual for scoring socioeconomic status for research on health behavior. *Public Health Rep* 1970;85:815-27.
- Webster J. Post-caesarean wound infection: A review of the risk factors. *Aust N Z J Obstet Gynaecol* 1988;28:201-7.
- Wodajo S, Belayneh M, Gebremedhin S. Magnitude and factors associated with post-cesarean surgical site infection at hawassa university teaching and referral hospital, Southern Ethiopia: A cross-sectional study. *Ethiop J Health Sci* 2017;27:283-90.
- Moulton LJ, Munoz JL, Lachiewicz M, Liu X, Goje O. Surgical site infection after cesarean delivery: Incidence and risk factors at a US academic institution. *J Matern Fetal Neonatal Med* 2018;31:1873-80.
- Scheck SM, Blackmore T, Maharaj D, Langdana F, Elder RE. Caesarean section wound infection surveillance: Information for action. *Aust N Z J Obstet Gynaecol* 2018;58:518-24.
- McMahon MM, Bistrrian BR. Host defenses and susceptibility to infection in patients with diabetes mellitus. *Infect Dis Clin North Am* 1995;9:1-9.
- Stadelmann WK, Digenis AG, Tobin GR. Impediments to wound healing. *Am J Surg* 1998;176:39S-47.
- Schneid-Kofman N, Sheiner E, Levy A, Holcberg G. Risk factors for wound infection following cesarean deliveries. *Int J Gynaecol Obstet* 2005;90:10-5.
- Avila C, Bhangoor R, Figueroa R, Santorelli J, Ogburn P, Desan PH. Association of smoking with wound complications after cesarean delivery. *J Matern Fetal Neonatal Med* 2012;25:1250-3.
- Morain WD, Colen LB. Wound healing in diabetes mellitus. *Clin Plast Surg* 1990;17:493-501.
- Várkonyi I, Makai I, Papdiné Nyíri G, Bacskó G, Kardos L. Postoperative surveillance of wound infection after cesarean section at Kenézy Hospital, Debrecen, Hungary. *Orv Hetil* 2011;152:14-22.
- Gong SP, Guo HX, Zhou HZ, Chen L, Yu YH. Morbidity and risk factors for surgical site infection following cesarean section in Guangdong Province, China. *J Obstet Gynaecol Res* 2012;38:509-15.
- Björklund K, Mutyaba T, Nabunya E, Mirembe F. Incidence of postcesarean infections in relation to HIV status in a setting with limited resources. *Acta Obstet Gynecol Scand* 2005;84:967-71.
- Semprini AE, Castagna C, Ravizza M, Fiore S, Savasi V, Muggiasca ML, *et al.* The incidence of complications after caesarean section in 156 HIV-positive women. *AIDS* 1995;9:913-7.
- Urbani G, De Vries MM, Cronjé HS, Niemand I, Bam RH, Beyer E. Complications associated with cesarean section in HIV-infected patients. *Int J Gynaecol Obstet* 2001;74:9-15.
- Sekirime WK, Lule JC. Maternal morbidity following emergency caesarean section in asymptomatic HIV-1 infected patients in Mulago Hospital Kampala, Uganda. *J Obstet Gynaecol* 2008;28:703-9.
- Tran TS, Jamulitrat S, Chongsuvivatwong V, Geater A. Risk factors for postcesarean surgical site infection. *Obstet Gynecol* 2000;95:367-71.
- Thornburg LL, Linder MA, Durie DE, Walker B, Pressman EK, Glantz JC. Risk factors for wound complications in morbidly obese women undergoing primary cesarean delivery. *J Matern Fetal Neonatal Med* 2012;25:1544-8.
- Myles TD, Gooch J, Santolaya J. Obesity as an independent risk factor for infectious morbidity in patients who undergo cesarean delivery. *Obstet Gynecol* 2002;100:959-64.